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Durability of the non-dezincification resistant CuZn40Pb2 brass in Scandinavian waters

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ABSTRACT

Typically water quality in Scandinavia has low alkalinity and hardness, and is consequently corrosive to the metallic materials. During the last years brass materials used in drinking water systems have been under discussion because of the amount of the lead content and relevant migration into the drinking water. In Scandinavia the requirement for the use of dezincification resistant brass in drinking water installations is widely utilized and hence, CuZn36Pb2As (CW602N) brass alloy is the type of brass that is mostly installed. In this study, the use of non-dezincification resistant brass alloy CuZn40Pb2 (CW617N) in drinking water systems in Rauma, Finland is examined using real-life distribution network built in the office building Technology Center Sytytin. This brass alloy is accepted to use in fittings or ancillaries in contact with drinking water for example in Germany and in the Netherlands. The acceptance is based on metal leaching data from a long-term rig test (EN 15664-1), showing that the release of lead and other harmful metals is below the parametric values given in the EU's Drinking Water Directive.

In this study the brass couplings manufactured from CuZn40Pb2 brass possess dezincification after five years of use in drinking water systems delivering water from Rauma water work. The main reason for the dezincification type of corrosion lies in the high sulfate and chloride concentrations as well as in low alkalinity. In this case the high concentrations of sulfate are mainly responsible of the dezincification of brass couplings. Typically, due to the aggressiveness of the water and consequent general corrosion from all brass materials, the drinking water quality is deteriorated by high dissolved concentrations of lead, copper and zinc. It is evident that CuZn40Pb2 brass cannot be used and demand for the use of dezincification resistant brass in water systems is extremely important in order to avoid expensive failures and problems caused by leakages.

1. Introduction

Typically, water quality in Scandinavia with low alkalinity and hardness is consequently corrosive to materials. During the last years brass materials targeted to use in drinking water systems have been under discussion because of the amount of the lead content and relevant migration into drinking water. In Scandinavia, the requirement for the use of dezincification resistant brass in drinking water installations is widely utilized and hence, CuZn36Pb2As (CW602N) brass alloy is the type of brass that is mostly installed. In this study, the use of non-dezincification resistant brass alloy CuZn40Pb2 (CW617N) in drinking water systems in Rauma, Finland is examined using real-life distribution network built in the office building Technology Center Sytytin. This

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Table 1
Water quality of the drinking supplied by Rauma water work.

	Minimum value	Maximum value	Average value
Chloride (mg/l)	11.0	15.1	13.6
Sulfate (mg/l)	86.8	130.0	106.4
pH	7.76	8.69	8.25
Conductivity (μS/cm)	319.1	411.7	366.3
Hardness (mmol/l)	1.1	1.6	1.3
Alkalinity (mmol/l)	0.36	0.64	0.49
Copper (μg/l)	2.6	17.4	9.2
Zinc (μg/l)	5.7	67.1	23.8
Lead (μg/l)	0.3	4.8	0.89

brass alloy is accepted to use in fittings or ancillaries in contact with drinking water for example in Germany and in the Netherlands. The acceptance is based on metal leaching data from a long-term rig test (EN 15664-1), showing that the release of lead and other harmful metals is below the parametric values given in the EU's Drinking Water Directive.

There are several corrosion indices developed to describe the impact of water quality on metallic materials.

Historically, the target has been in creating simple corrosion indices that can evaluate the corrosion potential of the different waters in order to find responses to source water changes and timely implement needed corrosion prevention measures.

The Langelier Index (LI) is an indicator of whether suitable conditions exist for the precipitation of calcium carbonate, and is commonly used to indicate the stability of the source waters due to the evidence that calcium carbonate films inhibit corrosion to some degree [1]. The calcium carbonate precipitation potential (CCPP) is the amount of calcium carbonate that will precipitate or dissolve from the solution as it comes to equilibrium with solid $CaCO_3$ [2]. Riddick developed a corrosion index (RCI) that gives weight to several factors, i.e., CO_2, hardness, alkalinity, chloride ion, nitrate ion, silicate and dissolved oxygen that contribute to corrosion in distribution systems [3]. In 1944 Ryznar used the pHs as calculated by Langelier equation to produce a stability index (RSI) [4]. A rearranged form of the solubility expression was used by McCauley in 1960 and termed as the driving force index (DFI) [5]. The aggressiveness index (AI) is a measure of the tendency of water to deteriorate the structure of asbestos cement pipes [6].

The Larson ratio (LR) is developed from the relative corrosive behavior of chlorides and sulfates to the protective properties of bicarbonate [7]. They deduced that the corrosivity of air-saturated waters is dependent on the proportion of corrosive agents to the inhibitive agents and their concentrations. Larson and Skold observed that calcium in the presence of alkalinity, regardless of pH or saturation index, is an effective inhibitor of corrosion

$$\mathrm{LR} = \left([\mathrm{Cl}^-] + \left[\mathrm{SO}_4^{2-}\right]\right)/[\mathrm{HCO}_3^-])$$

where [ ] is expressed in milliequivalents per liter. Any value above 0.5 is considered corrosive [7].

Feigenbaum et al. developed an empirical index that incorporated the effect of calcium carbonate solubility as well as chloride and sulfate ions [8]. Based on laboratory loop studies and field investigations, Pisigan and Singley observed that the buffer capacity was a better indicator of corrosion rates than alkalinity [9]. Rossum and Merrill (1983) conducted a review of some common

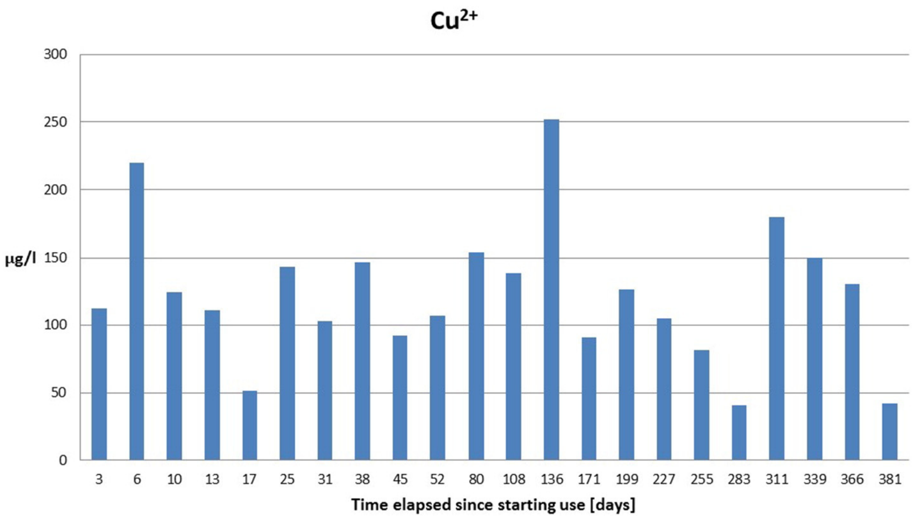

Fig. 1. The measured Cu^{2+}-ion concentration in the cold water collected in the first floor tap.